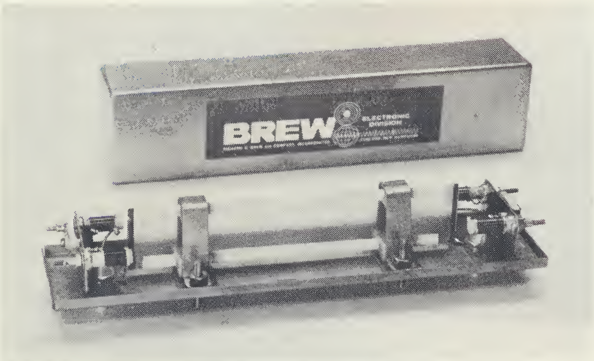
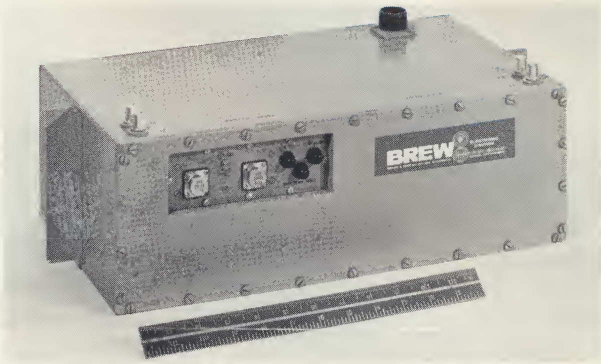
**BREW** ELECTRONIC DIVISION

# STRIP DELAY LINES

RICHARD D. BREW and COMPANY, INC.
CONCORD, NEW HAMPSHIRE




STRIP-LINE — 5 mc. dispersive




STRIP-LINE — 1.6 mc. temp. controlled.

### DISPERSIVE STRIP LINES FOR PULSE COMPRESSION RADAR (CHIRP FILTER)

- Maximum design through solid state media
- Maximum power utilization from output tube
- Maximum increase in radar range
- Maximum resolution of long duration pulses

### NON-DISPERSIVE STRIP LINES

- Digital data storage
- Buffer lines slow down pulse return rate for simple and inexpensive readout
- Transverse equalizer for phase and delay error correction
- Standard delay applications


STRIP-LINE — 5 mc. tapered

### DISPERSIVE STRIP DELAY LINES

The design and development of dispersive delay lines stems from two major problems with World War II radars, namely, limited range, and the need for improved resolution. Since peak power is limited, the use of a wider pulse to increase average power would decrease resolution capability unless a technique such as pulse compression was used.

Pulse compression permits the use of a long transmitted pulse to increase the average power output of the radar transmitter. This long pulse may be linearly frequency modulated by the use of a dispersive ultrasonic delay line.

The reflected frequency modulated pulses are processed and again applied to a dispersive delay line. The delay change versus frequency characteristic of the dispersive line causes the varying frequency components of the received signal to be proportionally delayed in time and thus yield narrow pulses of greatly increased amplitude.

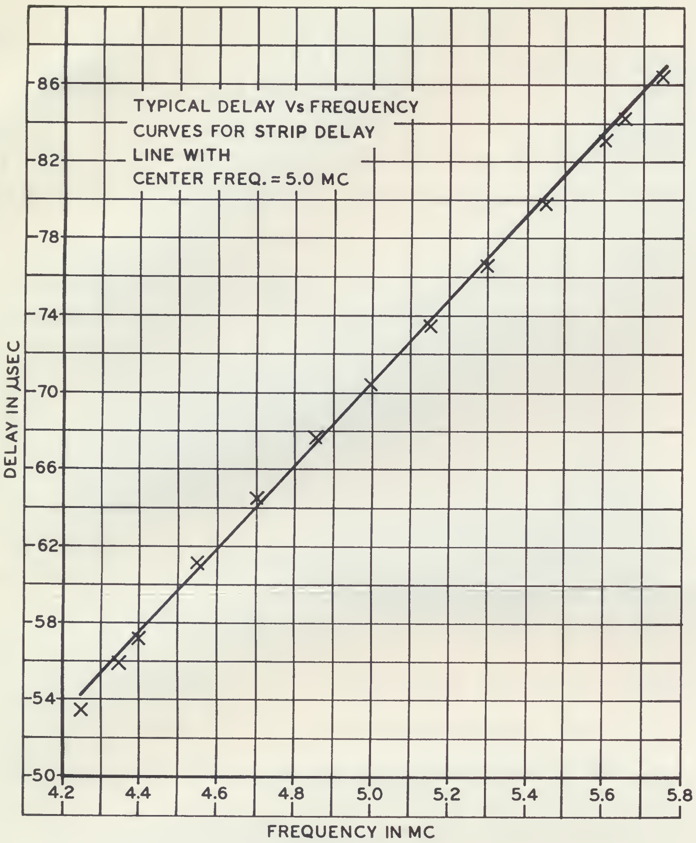
Since most noise is not compressed with the reflected pulse, the range of the system is increased and resolution is improved by virtue of the short compressed pulse.

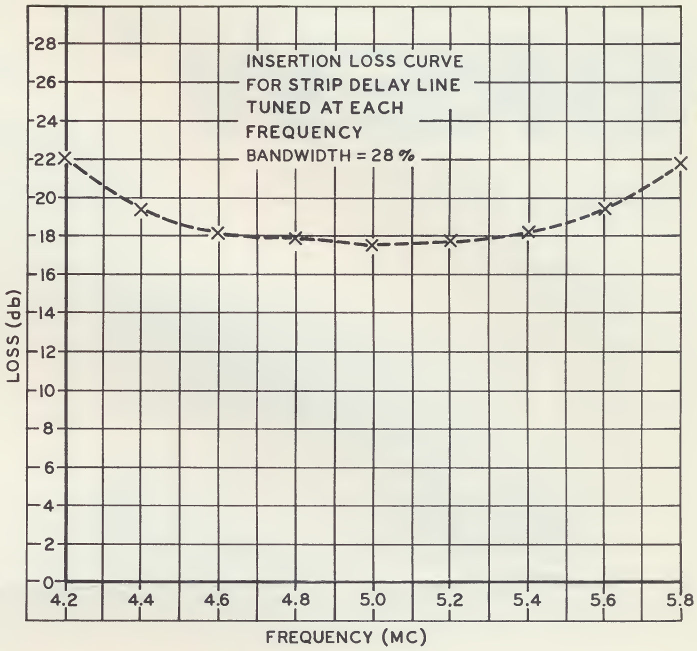
Brew strip lines accomplish this in one solid states medium. They preclude the use of complicated matched filtering LC networks and associated tuning.

**ASSOCIATED NETWORKS**

**Drivers • Amplifiers • Timers • Filters**

NOW MANUFACTURED BY ANDERSEN LABORATORIES, INC.



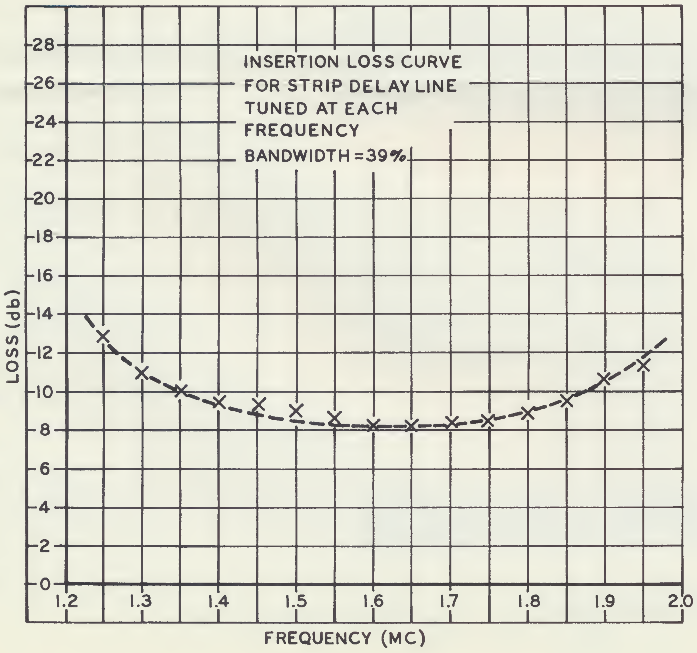



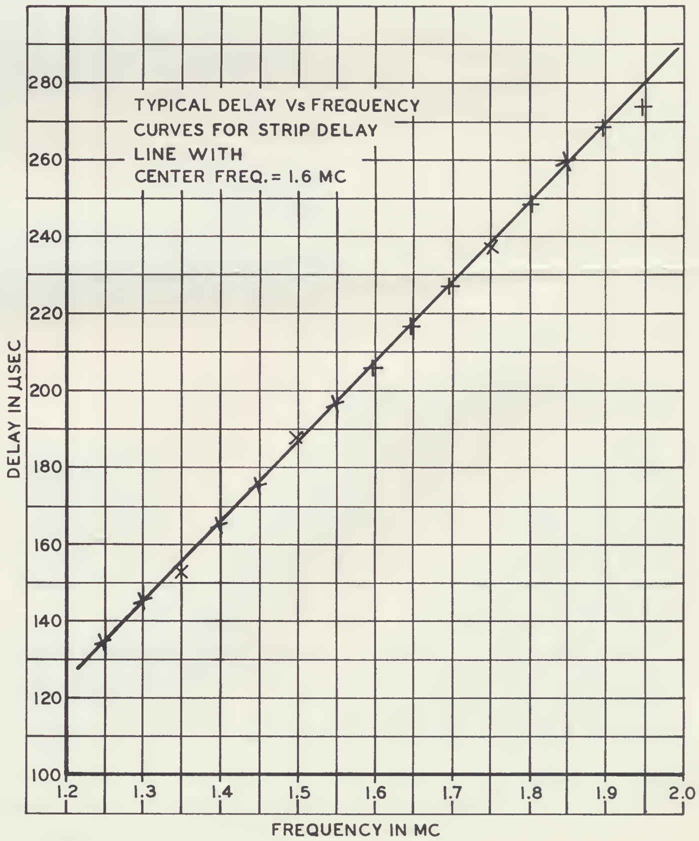

## GRAPHS

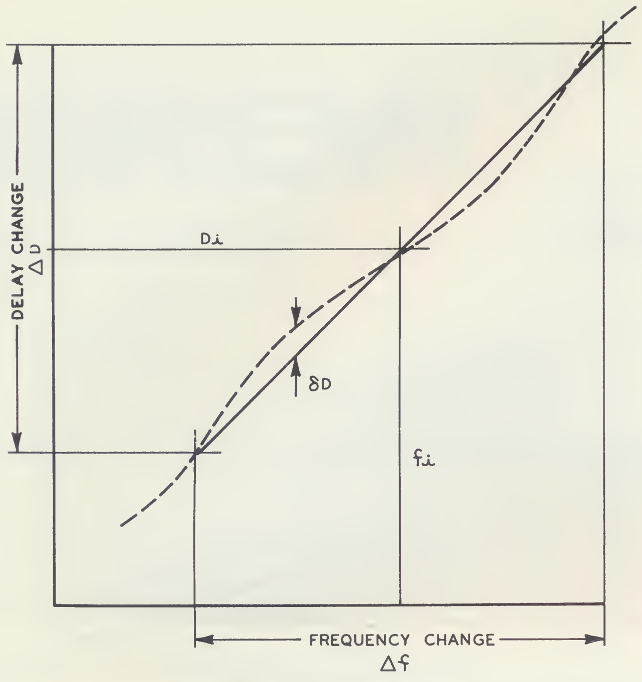
The graphs on this page present the delay change versus frequency and the loss versus frequency for typical delay lines having a midband frequency of 5 megacycles and 1.6 megacycles.

## ADVANTAGES OF BREW DISPERSIVE TYPE STRIP DELAY LINES

- Increased Radar Range
- Better Radar Resolution
- High Reliability
- Stable Under MIL Environment
- Light Weight





DELAY DISPERSION GRAPH

The delay dispersion graph shows the delay change versus frequency relationships for the ideal delay line and indicates the typical deviation from the ideal condition. This graph is helpful in analyzing the delay line specifications presented in the chart below. Each column of specifications is for a specific delay line built and tested.

The following relationships define the present "State-of-the-Art" for dispersive strip delay lines.

$$\frac{\Delta D \cdot \Delta f}{1} = \text{compression ratio}$$

$$2 \leq \frac{\Delta D f_i}{\Delta f D_i} \leq 3 \quad \text{for best linearity in a tapered thickness line}$$

$$\frac{\Delta f}{f_i} \leq 45 \text{ percent}$$

$$\frac{\Delta D}{D_i} \leq 1$$

$$f_i \leq 6 \text{ megocycles}$$

$$D_i \leq 4000 \text{ microseconds}$$

**DELAY DISPERSION GRAPH**

Solid Line = ideal delay dispersion

Dash Line = typical delay dispersion

$\delta D$ = delay linearity

$\Delta f$ = bandwidth

$\Delta D$ = delay change

$f_i$ = midband frequency

$D_i$ = midband delay

$\frac{\Delta f}{f_i}$ = bandwidth %

**SPECIFICATIONS FOR DISPERSIVE STRIP–LINES OF VARIOUS COMPRESSION RATIOS**

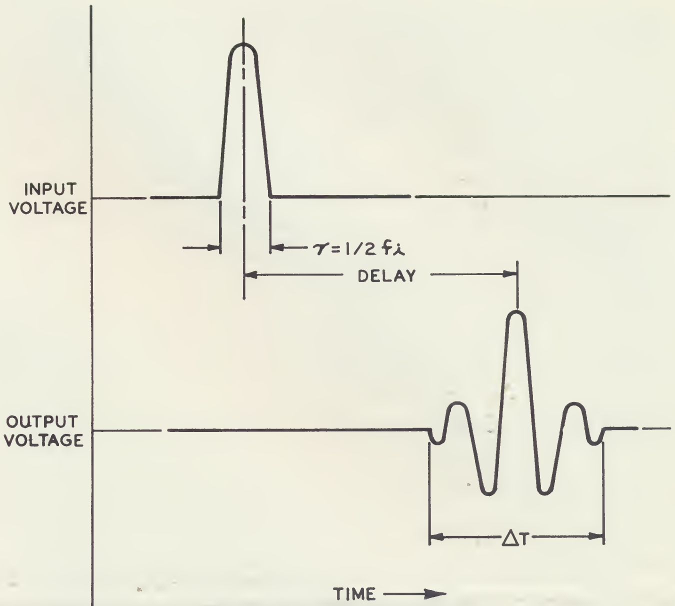
| SPECIFICATIONS | COMPRESSION RATIO | | | | |
|---|---|---|---|---|---|
| | 21 | 30 | 35 | 78 | 500 |
| Bandwidth | 2.1 mc. | 0.1 mc. | 1.3 mc. | 0.625 mc. | 0.8 mc. |
| Delay Change | 10.0 usec. | 300.0 usec. | 27.0 usec. | 125.0 usec. | 625.0 usec. |
| Midband Frequency | 5.0 mc. | 2.0 mc. | 5.0 mc. | 1.6 mc. | 2.0 mc. |
| % Bandwidth | 42.0 % | 5.0 % | 26 % | 39 % | 40 % |
| Midband Delay | 175.0 usec. | 3000.0 usec. | 60.0 usec. | 200.0 usec. | 1500.0 usec. |
| Spurious signals | 35 db | 35 db | 35 db | 35 db | 35 db |
| Delay Linearity | ±0.2 usec. | ±1.0 usec. | ±0.3 usec. | ±0.3 usec. | ±2.0 usec. |
| Insertion Loss | 20 db | 35 db | 12 db | 15 db | 25 db |
| Size | 1"x2"x23" or 2"x7"x15" with 50% vol. available for other networks | 2"x15"x15" with 20% vol. available for other networks | 1"x2"x10" | 1"x2"x25" or 2"x8"x15" with 50% vol. available for other networks | 2"x15"x15" with 30% vol. available for other networks |

## NON DISPERSIVE STRIP-LINES FOR DATA STORAGE

Digital data may be stored by many means. Among those frequently used are magnetostrictive and quartz delay lines. Two problems associated with these types of lines are high losses and sensitivity to shock and vibration. Brew strip-lines overcome both difficulties.

The basic concept of a strip-line is a long, thin strip of delay medium with ceramic shear mode transducers bonded to the narrow end surfaces. This long strip, acting as an acoustic waveguide, allows the input pulse to be propagated by a number of modes, with various amounts of dispersion and low loss. One of these shear modes exhibits zero dispersion and, therefore, is useful for digital data storage.

The following relationships, in conjunction with the input-output graph, define the present "State-of-the-Art" for non dispersive strip-lines.




LOW FREQUENCY STRIP-LINE
INPUT-OUTPUT PULSE RELATIONSHIPS

$\Delta f =$ bandwidth

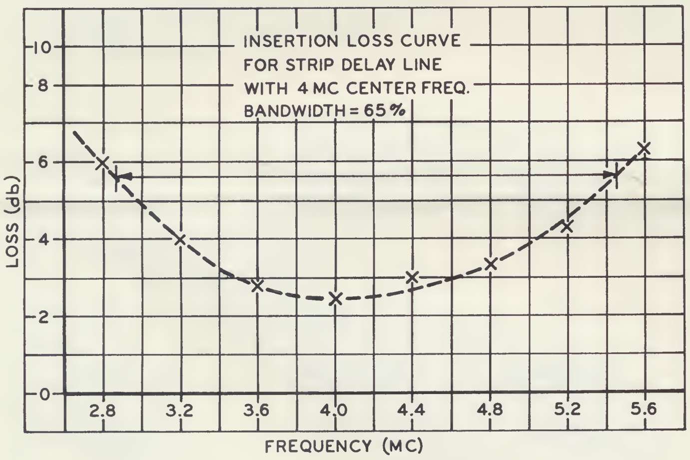
$\frac{1}{\Delta T} \cong$ bit rate (for complete pulse resolution)

$\Delta T \cdot \Delta f \cong 2$ (empirical formula)

$\frac{\Delta f}{f_i} \leq .65$ (empirical formula)

$\therefore$ Bit rate $\lessapprox .325\, f_i$

When the equation $\tau = 1/2 f_i$ is maintained, optimum pluse shape, maximum amplitude, and minimum width is obtained. This equation defines $\Delta T$ and the above relationships follow.




## ADVANTAGES OF BREW DATA STORAGE STRIP-LINES

- Very Low Insertion Loss
- Wide Bandwidth
- Less Susceptible to Shock and Vibration
- Low Cost Per Bit
- Delays up to 50 Msec.
- Frequencies up to 5 Mc.
- Compact Size—High Bit Density
- Low Noise Level
- Up to 20,000 Bit Storage Capacity

## ASSOCIATED DELAY LINE NETWORKS

Brew Company Engineers will design and develop electronic networks for use with ultrasonic delay lines as follows:

Pre Amplifiers
Post Amplifiers
Reshaping Circuits
Compensating Networks
Equalizers
Weighting Networks

These networks can be incorporated as part of the delay line packages. We invite your inquiry for a delay line package with zero loss and minimum pulse distortion.

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Area Code—603-225-6605